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Development of wireless and intelligent home automation system

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Abstract

The Intelligent Home Automation System (IHAS) is usually a cell phone web -based application that enables end users in order to keep track of in addition to manage home/office appliance using their mobile system. The main objective of this system is developed to facilitate home users, especially domestic electrical appliances with simple controls. In addition, it can save the cost of electricity for lighting can be controlled to suit the user. Generally, most home appliances controlled from a distance using a remote control. Has created a system for controlling home lighting from a certain distance, which replaces the remote control using mobile smartphone. To make the smartphone to function as a remote control, an application was developed using Android technology. App Inventor software used for designing applications intended. Hardware microcontroller Arduino UNO R3 which is used to connect the smartphone to the electrical equipment. The system has been tested by developing a mini model and take into account the situation in the domestic home. The test is based on the level of control for wirelessly using Bluetooth and the distance between the lamp and the smartphone. The results of this test, the system can be used on equipment or other home appliances for the purpose of controlling or adjustment. In addition, the security system was also highlighted in a typical system, using the global system for mobile (GSM), it can be warned and notified to the consumer where there is a gas leak or the presence of a person in the vicinity of the residence.

Keywords: *arduino, GSM, home automation, smartphone, wireless*

1. Introduction

According to World Health Organization (WHO), there are already 1 billion people experiencing disability globally in year 2012 [1]. The amount has occupied 15% of the world's population and growing due to population ageing. The implementation of Intelligent Home Automation System (IHAS) at home is one of the great steps towards the integration of severely physically disabled and elderly people. The system is being developed to overcome the problems described above, allowing the end-user to perform home appliances control and accomplish some daily life important tasks by control with smartphone. The application designed for portable smart phones through a Bluetooth wireless network provides users with a simple interface to interact with appliances at home [2]. With increasing age, people tend to forget things which may create safety problems for them. Tragedies happen such as thefts especially late at night or when leaving the home. This is probably because the house does not provide any secure system. Home security has been a major issue where crime is increasing. People are scared of leaving home alone without a proper security. This leads to the research and development of various security systems [3-5].

According to Hedaoo and Morey [6], concept of home wireless system has been around for a long time. Home automation provide a remote interface to home appliances such as lamp, fan and socket plug. There are many method for example via telephone line, wireless transmission or the internet, to provide control and monitoring via a smart phone or web browser [6]. Javale et al., [7] develop a home automation with security system by using Android Accessory Development Kit (ADK). The design is based on a standalone embedded system board Android ADK at home. Home appliances are connected to the ADK and communication is established between the ADK and Android mobile device or tablet [7]. It is reported that

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Soliman [8] study the planning and execution methods for just a cellular real-time property automation technique dependant on Arduino Uno microcontroller as middle controllers. The particular proposed technique features has two operational modes [8]. The very first one is denoted like a manually–automated setting that person can certainly keep an eye on and management the property home appliances through everywhere around the globe while using the cell phone via Wi-Fi transmission technologies. The second one is described a new self-automated setting that creates this controllers in order to allow you to overseeing and handling unique home appliances in the house automatically with response to this alerts derives from this linked devices. To aid this performance in the proposed process, a new computer hardware execution along with Matlab-GUI software with the proposed technique is actually executed and also the consistency in the technique is actually launched. The particular proposed technique is actually proved to be a simple, less expensive and versatile that will making it a suitable as well as a great customer with the smart property potential.

According to Assafa [9], in the routine outline of home security frameworks, just the property is commonly observed, without contemplate the physical control parts of the house itself. Furthermore, the term security is not entirely all around characterized in perspective of the way that there is usually a period defer between the alert framework going on and genuine entry of the security faculty. This paper shows the advancement of a home security and observing framework that is suitable where the customary security substructure that are generally worried about controlling robbery, social event proof against trespassing thus on failure [9]. The outline and execution points of interest of this new home control and security framework which is taking into account field programmable entryway exhibit has been discussed. The user here can interact directly with the system through a web-based interface over the Internet, while home appliances like fans, lights, door locks, and gates are controlled remotely through a user-friendly web page. This paper will discuss the development of a security system that integrates with an Android mobile device using Global System for Mobile Communications (GSM) shield. Home security has been a major issue where crime is increasing. In addition, there is need to automate home so that the user can take the advantage from technological advancement. This paper presents a model that will provide security to their home, office or cabin by using Short Message Service (SMS) and GSM technology.

2. Methodology

The developing process of intelligent home automation system involves in design of the main controller circuit including hardware devices and software configurations, which provide the platform for the whole system design. The methodology implemented in the system are decided based on the studies done for previous research. This part will describes the methodology employed and consideration taken into account on this development. It began with the discussion of the project workflow followed by the system design procedures, techniques and tools utilized. The development of this system will be involve with both hardware and software.

2.1. Block Diagram of the System

Figure 1 shows the overall diagram for home automation system that easier to understand. The project develops for controlling home appliances remotely and providing security when the user is away from the place. Then, the system also include SMS based and use wireless technology like Bluetooth to revolutionize the standard of living. This system is wireless therefore more adaptable and cost-effective. There are two subsystems, the one appliances control which is responsible for controlled electrical appliances and the other subsystem being security alert that responsible for security intrusion detection and may also for security gas leakage that exceeds certain level. For both security, GSM technology was used for transmission of sensor data from sender to receiver. User can transmits signal instructions to Arduino UNO as well as the technique normally takes steps in opposition to those guidance. Hence the task offers a system that allows user to regulate devices through wireless Bluetooth and also produce protection on discovery involving intrusion as well as gas leakage through text message applying GSM technological.

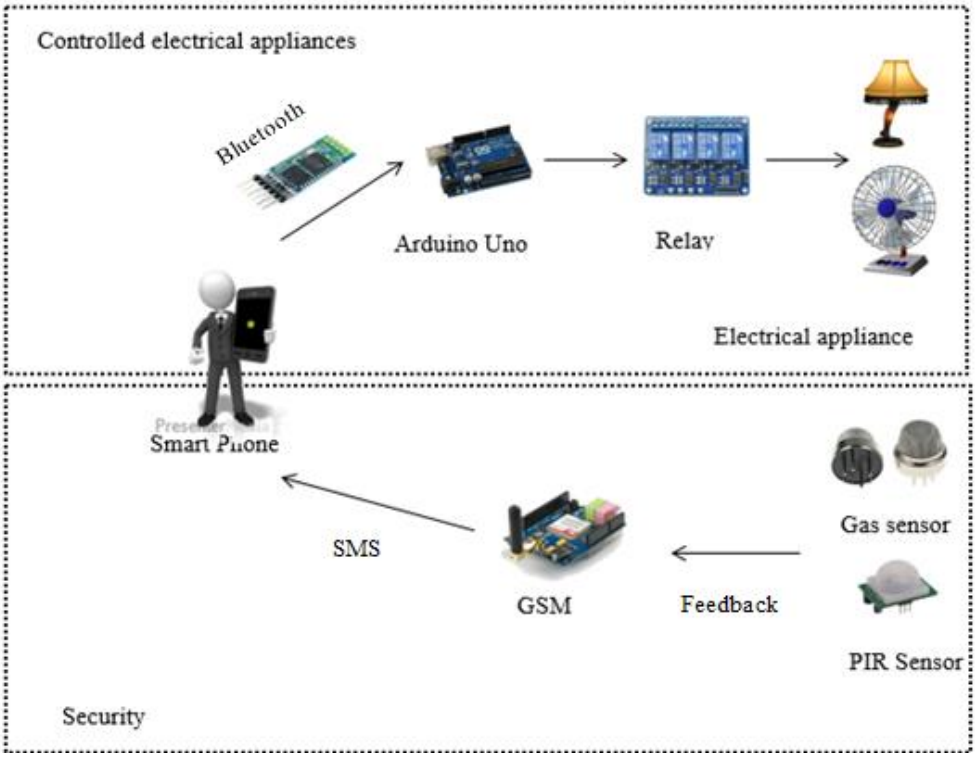
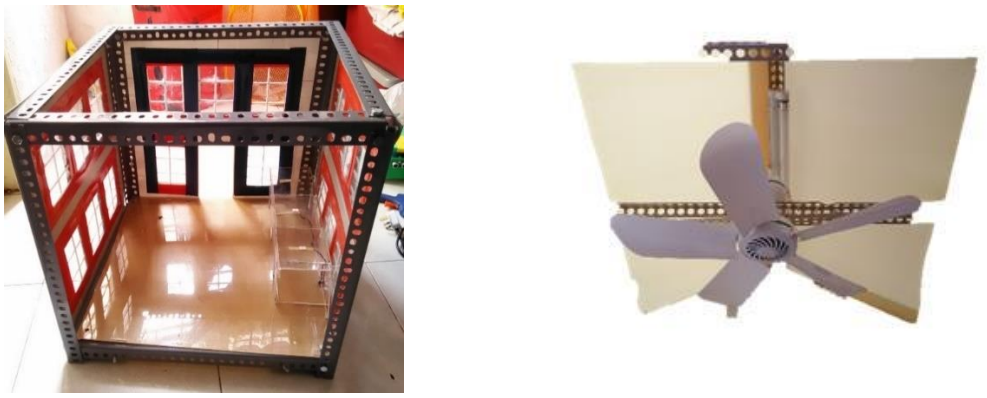


Figure 1. Full system overview

2.2. Mechanism System Design of Home Automation System

The development of mini home system can be divide into 3 parts which are hardware system design, control system design, and software programming development. In hardware system design, will focused to ensure the mechanical hardware is reliability and modularization. The part of control system design is concern about the electrical hardware and position of the sensor. In software development part, the programming of electrical appliances, PIR sensor, MQ-2 gas sensor have been made by using Arduino software.

For this research, home system was built based on the measurement that have been design. The size for this structure 520 mmx520 mmx520 mm. Figure 2 shows the structure of mini home automation system. For electrical part, the schematic have been designed and then testing on project board. It is easy for testing and troubleshooting as shown in Figure 3.



(a) (b)

Figure 2. Structure for mini home automation system (a) hall with 3 rooms (b) fan & lamp

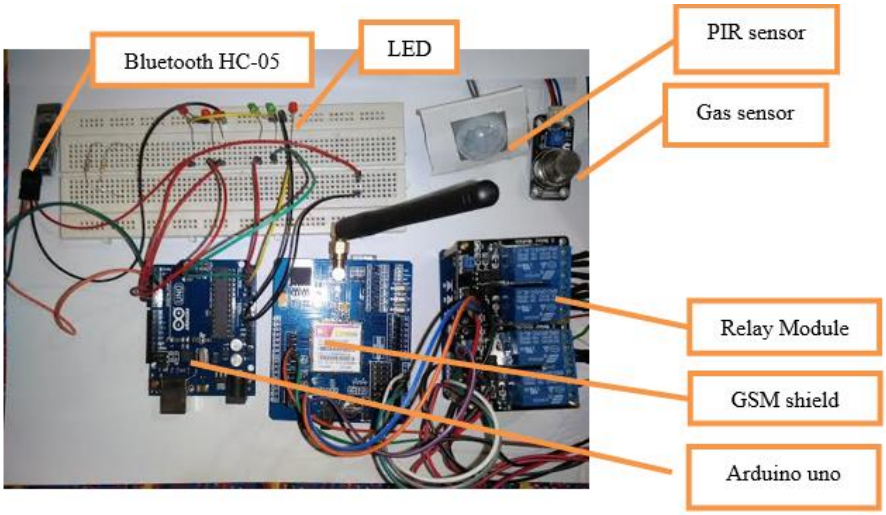


Figure 3. Electrical system

For the software design, the MIT app inventor was designed based on how many system that need to be controlled. So, from Figure 4 it shows six button that have been designed and easy for user to use.

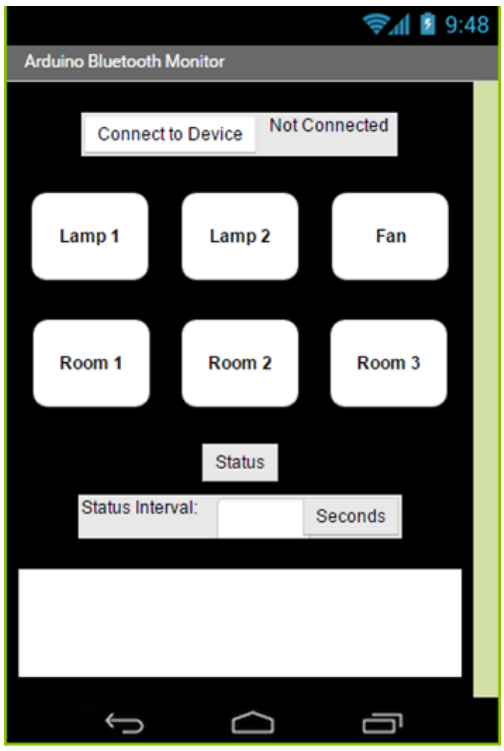


Figure 4. User interface selection

3. Result and Discussion

This part will explain about the results achieved in the research. A few discussions on problem solving during process and experiment of completing this project. The data collection is using types of gas sensor MQ2 for LPG gas that useful for gas leakage detecting in home.

3.1. Lamp ON-OFF Control Test

User can selects “lamp-on” for ON light and “lamp-off” for OFF light as control from MIT app inventor. By selecting desired command, the control button will be processed by the system. If the command is “lamp-on” the lamp will turn on. The lamp will not change until a command “lamp-off” is received. For this system, there are 6 output that have been installed with Arduino Uno, it consist of 3 output AC which is lamp 1 on Digital Pin 4, lamp 2 Digital pin 5 and fan on Digital pin 6. Another 3 output DC is consist LED 1 on analog pin A2, LED 2 on analog pin A3 and LED 3 on analog pin A4 as shown in Table 1 below.

Table 1. Pin Number for Output

Output	Pin Number
Lamp 1	4
Lamp 2	5
Fan	6
Room 1	A2
Room 2	A3
Room 3	A4

3.2. Wireless System Test

Bluetooth is one of the technology or method in wireless communication. Based on the short-range wireless connection 2.45 GHz frequency band, it will connects between multiple devices like smartphone. The connection can be point-to-point or multipoint where the maximum range is 10 meters. From this range, the electrical appliances can be controlled wireless. The connections of the Bluetooth module sometime confusing since TXD goes to Rx and RXD goes to Tx. This is because a transmission coming out of TXD pin of the Bluetooth module must be received by Arduino on the Rx Pin 0; similarly a transmission of Arduino, Tx Pin 1 must reach the Bluetooth module on its RXD pin. Bluetooth transmission testing done to see how much capability a HC-05 Bluetooth module can send data from smartphone to be received by Arduino Uno as a result.

Table 2 shown the result for the physical capability Bluetooth module to sending data from smartphone to Arduino. Condition without barriers that successfully connected around 15 meter and condition with barriers around 10 meter. By using HC-05 Bluetooth module, means the transmitter can receive the signal approximately 10-15 meter, which means just enough to communicate between different rooms with a restriction.

Table 2. Bluetooth Transmission Experiment Result

Result For Sending Data By Using HC-05 Bluetooth Module			
		Smartphone to Arduino Uno Connection	
Experiment	Distance (m)	Condition without barriers	Condition with barriers
1	2	Connect	Connect
2	5	Connect	Connect
3	10	Connect	Connect
4	15	Connect	Disconnect
5	20	Disconnect	Disconnect

3.3. PIR Sensor Test

There are numerous type of passive infra-red (PIR) in the market with different of specification. For this system, PIR motion sensor will be install at outdoor. Dual-tech motion sensor combination with microwave detection technology, PIR detection will give more accurate movement detection. Thus choose Dual-tech motion sensor can reduce the false alarm effective. Based on system develop by KAM Annuar et al, PIR sensor test to detect the moving person who wants to come inside with no pre-permissions [10]. When person detected into the PIR’s sight area about 3 m, this sensor reports this situation to the control panel. The control panel turns the intrusion alarm on and then will certainly send SMS towards cell phone. Figure 5 shows the hardware connection for PIR sensor with GSM shield.

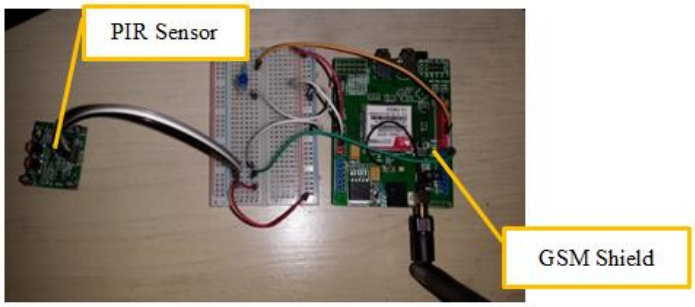


Figure 5. Connection PIR sensor with GSM shield

Based on the Table 3, it can conclude that the PIR sensor will detect human motion with maximum 3 meter. For this experiment, the result shows that the plant cannot detect by PIR sensor. The testing measurement for distance and output voltage for PIR sensor to object can be summarize as shown in Table 4 below. It shows that, the maximum distance object detection by PIR sensor up to 300 cm.

Table 3. Object Detection Experiment Test

Distance (m)	Object	Experiment	Result	Status (object)
1	Human	5 times	5 times	Sensor detect
1	Plant	5 times	No feedback	Sensor not detect
1	Cat	5 times	2 times	Sensor detect
3	Human	5 times	5 times	Sensor detect
3	Plant	5 times	No feedback	Sensor not detect
3	Cat	5 times	2 times	Sensor detect

Table 4. Object Detection based on Distance

Distance (cm)	Output voltage (Volt)	Output Logic	Status (object)
10	4.8	Active High	Detect
30	4.8	Active High	Detect
60	4.8	Active High	Detect
100	4.8	Active High	Detect
200	4.8	Active High	Detect
300	4.8	Active High	Detect
400	0	Active low	Not detect

3.4. Gas Sensor Test

This system includes gas detector circuit system. It to prevent gas leakage based on the conditions either user is inside at home or not at home. Alarm of buzzer to alert user at home when receive signal detection of gases. Then the other condition (if outside home), user will receive information from the SMS signal. A message is sent to the concerned person using GSM in order to inform about the leakage of LPG gas. If the leakage still continues exhaust fan is turned ON using a solenoid valve relay. Further leakage leads to alarming of buzzer.

So that, this connection that have been made is for Tx of GSM shield connect to pin 2 of arduino, Rx to pin 3 and make the grounds of both the apparatus common have been connected. Power the gsm shield with a 12v external power source while running your device. This sensor gas will recognize the level of concentration of the gas exposed and convert it into voltage and directly sending it into Arduino. After transferring the data, Arduino will read the data into the digital format. Voltage output from the gas sensor (0-5) V will be read as (0-1024) decimal output in Arduino.

From the analysis, when the sensor value reached to the maximum value, then open serial monitor and wait serial monitor will show "status OK" and soon will send sms to the cellphone, the alarm will be on and the data will send to the user through GSM shield. From the Table 5 it shown that the sensor can be detect to selectively choose which will be controlled gas at the Arduino, LPG gas is in the range 4.02 to 3.98 volt. From the Table 6, shown result on the duration between gas sensor and stove gas. The gas leakage takes a short time to give the

signal to user through sms. Other that, the concentration of the gas also one of the main important part to detect the leakage of gas.

Table 5. Voltage Output based on Different Condition Gas

No	Condition	Voltage Output (Volt)			
1	Free air	0.44	0.47	0.48	0.44
2	AC air	0.44	0.45	0.45	0.55
3	Cigarette smoke	0.50	0.40	0.40	0.44
4	Perfume	0.55	0.50	0.40	0.39
5	Exhaust gas vehicles	0.40	0.42	0.42	0.42
6	LPG gas	4.02	4.01	3.98	4.01

Table 6. Time Taken for Sensor Detection

Distance Sensor (m)	Time taken (s)
1	20
2	45
3	60
4	120
5	180

4. Conclusion

As conclusion, the development of wireless and intelligent home automation system is the way to control home appliance through wireless. It introduced design and implementation of a low cost, flexible and wireless solution to the home Integration of Bluetooth and Wi-Fi technology in controlling home appliances can help and improve lifestyle of all user groups especially to the disabled and elderly people in term of safety and comfortable. The implementation of combined wired and wireless systems would be of most practical in designing a smart home system especially in cutting the system's installation cost for conventional homes.

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